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(71) Applicant: **WESTINGHOUSE ELECTRIC CORPORATION**
Westinghouse Building Gateway Center
Pittsburgh Pennsylvania 15222(US)

(72) Inventor: **Cooper, Frank William, Jr.**
115 Himalaya Road
Monroeville Pennsylvania(US)

(74) Representative: **Holzer, Rupprecht, Dipl.-Ing.**
Philippine-Welser-Strasse 14
D-8900 Augsburg(DE)

(54) **Mandrel for hydraulically expanding a tube into engagement with a tubesheet.**

(57) A mandrel (1) for hydraulically expanding tubes (3) into engagement with a tubesheet (5), wherein the body (7) of the mandrel is flexible and preferably has an electrically isolating impermeable layer (12) and an eddy current coil (33) adjacent the leading end thereof, the tube (3) into which the mandrel (1) is placed and the body (7) of the mandrel (1) serving as leads for operating the eddy current coil (33) in order to determine when the leading end of the mandrel (1) is adjacent the inner edge of the tubesheet (5). With such a mandrel, also remote and obstructed tube can be reached and the mandrel can be properly positioned therein.

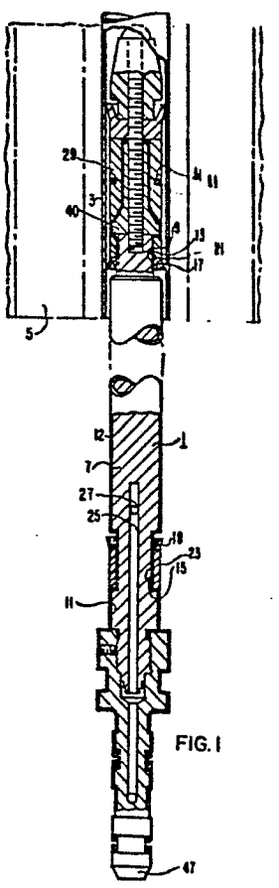

FIG. 1

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MANDREL FOR HYDRAULICALLY EXPANDING A TUBE INTO ENGAGEMENT WITH A TUBESHEET

This invention relates to a mandrel for hydraulically expanding tubes in a tube sheet of a heat exchanger.

U.S. Patents 3,977,068 and 3,979,810 describe a simple mandrel and method for hydraulically expanding tubes into engagement with a tubesheet. The use of such mandrels as described therein are not satisfactory as it is impossible to reach spaces with obstruction and it is difficult to determine exactly where the end of the mandrel is located.

When expanding a tube hydraulically, the portion of the tube expanded must be within the tubesheet as the pressurized fluid utilized causes the tube to yield and if the tube is not backed up by the tubesheet, it will burst. When hydraulically expanding a tube in a very thick tubesheet clad with a non-corrosive material on at least one side, the thickness of the tubesheet varies so that obtaining expansion generally throughout the portion in which the tube and tubesheet are contiguous requires very accurate positioning of the mandrel. Since one of the reasons for full-length expansion of a tube in a tubesheet is to eliminate crevice corrosion adjacent the inner edge of the tubesheet, accurate positioning of the leading end of the mandrel is critical. Utilizing a stop on the trailing end of the mandrel does not provide sufficiently accurate positioning of the leading end of the hydraulic expander relative to the inner edge of the tubesheet.

It is therefore the principal object of the present invention to provide a mandrel for hydraulically expanding a tube into engagement with a tubesheet, which mandrel can be brought to its proper position within a tube and which can be inserted into tubes which are not easily accessible.

With this object in view, the present invention resides in a mandrel for hydraulically expanding a tube into engagement with a tubesheet, said mandrel comprising a body portion having a leading and a trailing end with elastomer sealing members associated with said ends and means disposed in said trailing end for introducing pressurized fluid into the space between said sealing members characterized in that said body portion comprises a flexible structure disposed between the leading and trailing ends so as to fit into tubes adjacent an obstacle.

The invention will become more readily apparent reading the following description of a preferred embodiment thereof shown, by way of example only, in the accompanying drawings, in which:

Figure 1 is a partial sectional view of a mandrel for hydraulically expanding a tube, the mandrel is shown partially inserted into a tube in a tubesheet;

Fig. 2 is a partial sectional view of an alternate embodiment of a mandrel for hydraulically expanding a tube, the mandrel is shown partially inserted in a tube in a tubesheet; and

Fig. 3 is a partial sectional view of a mandrel showing the electrical circuitry of an eddy current coil disposed in the leading end of the mandrel.

As shown in Fig. 1, a mandrel 1 for hydraulically expanding a tube 3 into engagement with a tubesheet 5 of a heat exchanger comprises a body portion 7 having leading and a trailing end portions 9 and 11, respectively. The body portion 7 is coated or covered with an electrically isolating impermeable membrane 12 such as nylon or with some other electrically isolating material such as a ceramic.

Elongated grooves 13 and 15 are disposed adjacent the ends 9 and 11, respectively, of the body 7. Elastomer seal rings 17 and 19 having a C-shaped cross section or other sealing means such as O-rings are disposed on the in-board end of the grooves 13 and 15, respectively, so that the openings of the seals 17 and 19 face each other. Back-up rings 21 and 23 formed from a tough elastomer such as polyurethane are also disposed in the grooves 13 and 15, respectively, outboard of the C-shaped seal rings 17 and 19. The trailing end 11 of the body 7 has a centrally-disposed bore 25 and port 27 providing means for admitting pressurized fluid, demineralized water, to the area between the seal ring 17 and 19, the membrane 12 and the tube 3, whereby pressurized fluid is trapped in order to expand the tube into engagement with the tubesheet.

A plastic sleeve 29 is disposed on the leading end 9 of the body 7 outboard of the groove 13. The sleeve 29 is made of nylon or some other non-magnetic and non-conducting material. A circumferential groove 31 is disposed in the outer surface of the sleeve 29 and an eddy current coil 33 wound on a phenolic core with a stainless steel spacer ring disposed in the groove 31.

As shown in Fig. 3, the coil has two leads 35 and 37. One of the leads 35 is electrically connected to the body 7. The other lead 37 forms a finger or contact which makes contact with the tube 3. A non-magnetic shield 40 made of austhentic stainless teel is disposed to support the sleeve 29 and to prevent the formation of an interfering field in the vicinity of the coil 33. An electrical signal having a frequency of approximately 10 KHz is applied to the coil and by monitoring the response to the signal an indication of the relationship between the inner edge of the tubesheet and the eddy current coil can be ascertained with a high degree of accuracy. So that when a predetermined response is indicated, pressurized fluid can be supplied via the port 27 to expand the portion of the tube contiguous with the tubesheet and

adjacent the inner edge of the tubesheet.

A tube wiper 39 having a frustoconical portion 41 and made of a high-density polymer is disposed on the leading end 9 outboard of the sleeve 29 together with a bullet-shaped nose cone 43 made of a polymer such as nylon. Both the wiper 39 and the nose cone 43 are held in place by a brass machine screw 45 which is utilized to assure electrical contact between the body and the lead of the eddy current coil.

The trailing end 11 of the mandrel has a portion 47 which is not coated or covered by a membrane or an electrically isolating material and through which electrical contact is made to the one lead of the eddy current coil 33.

As shown in Fig. 2, a mandrel 1' has a body 7' which comprises a counterwound stranded stainless steel cable or wire rope 51 disposed between end portions 9' and 11'. The end portions 9' and 11' are welded to the cable 51. An impermeable membrane 12', formed of a material such as nylon, is continuous over the end portions 9' and 11' and the cable 51 preventing the pressurized fluid from penetrating the cable 51. If the pressurized fluid penetrated the cable 51, the cable could not withstand the forces exerted on the end portions by the pressurized fluid. The flexible cable 51 allows the mandrel 1' to fit into a tube disposed adjacent an obstacle such as a hemispherical wall even though the mandrel 1' is very long.

The mandrels hereinbefore described may be utilized repeatedly to hydraulically expand tubes into engagement with the tubesheet and may be positioned very accurately with respect to the inner edge of the tubesheet resulting in the tubes being expanded into engagement with that portion of the tubesheet which is adjacent to the inner edge thereof.

What we claim is:

1. A mandrel for hydraulically expanding a tube into engagement with a tubesheet, said mandrel comprising a body portion having a leading and a trailing end with elastomer sealing members associated with said ends and means disposed in said trailing end for introducing pressurized fluid into the space between said sealing members, characterized in that said body portion (7) comprises a flexible structure disposed between the leading and trailing ends (9, 11) so as to fit into tubes adjacent an obstacle.

2. A mandrel as claimed in claim 1, characterized in that said flexible structure is a stranded cable (51) with a layer of an impermeable material extending continuously over the flexible structure and said ends (9, 11).

3. A mandrel as claimed in claim 2, characterized in that an eddy current coil (33) is disposed in the leading end (9) of the body for indicating the position of the coil (33) relative to the edge of the tubesheet (5) and said layer of impermeable material is also an electrically insulating material, said eddy current coil (33) having two leads, one of which is electrically connected to the body (7) of the mandrel and the other of which is in electrical contact with the tube (3).

4. A mandrel as claimed in claim 3, characterized in that at least one finger (37) is utilized to make electrical contact between the other lead of the eddy current coil (33) and the tube (3).

5. A mandrel as claimed in claim 2, 3, or 4, characterized in that a non-magnetic sleeve (29) is disposed over the leading end (9) of the body (7) and said eddy current coil (33) is disposed in a circumferential groove (31) in said sleeve (29).

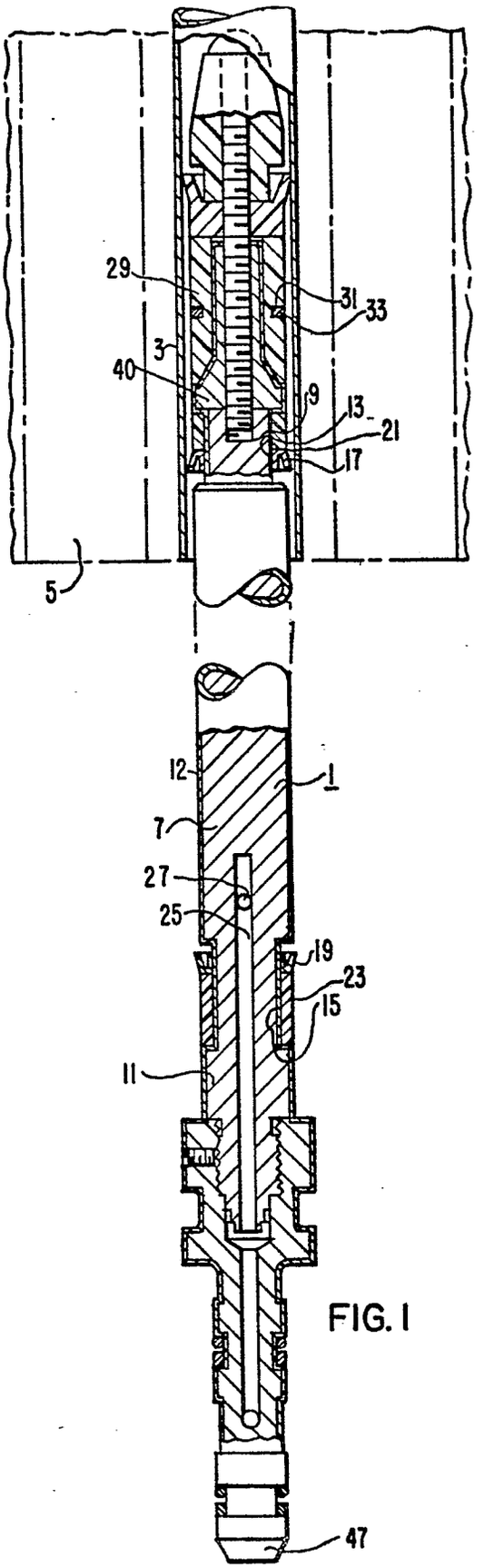

FIG. 1

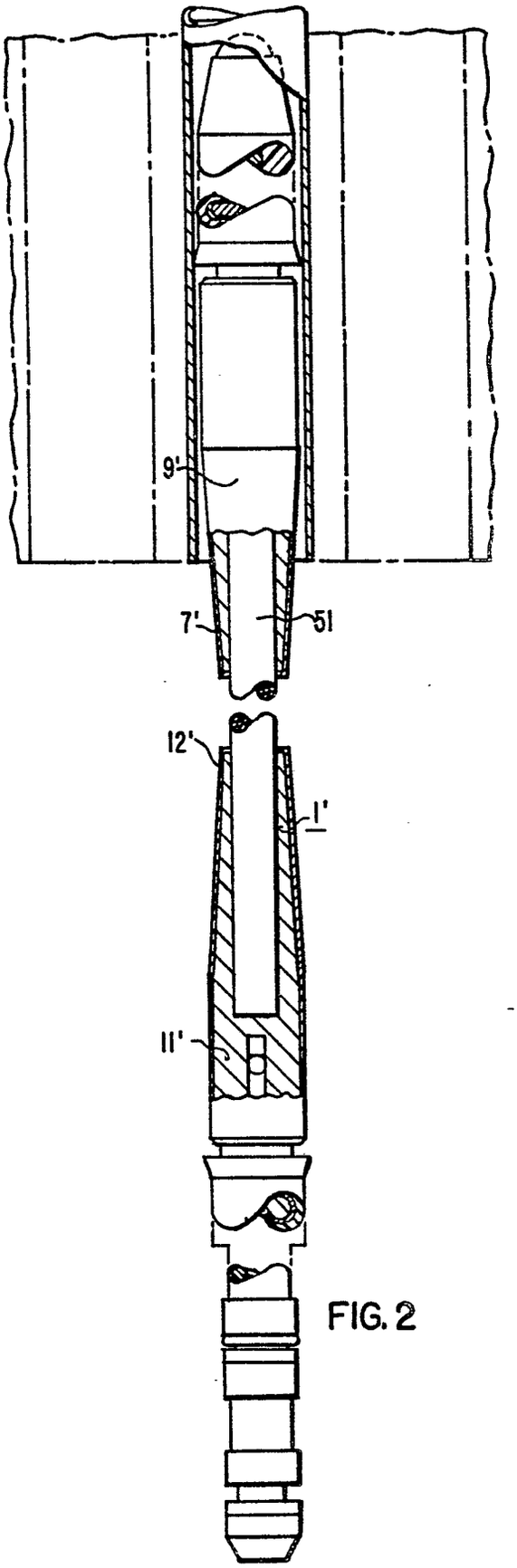

FIG. 2

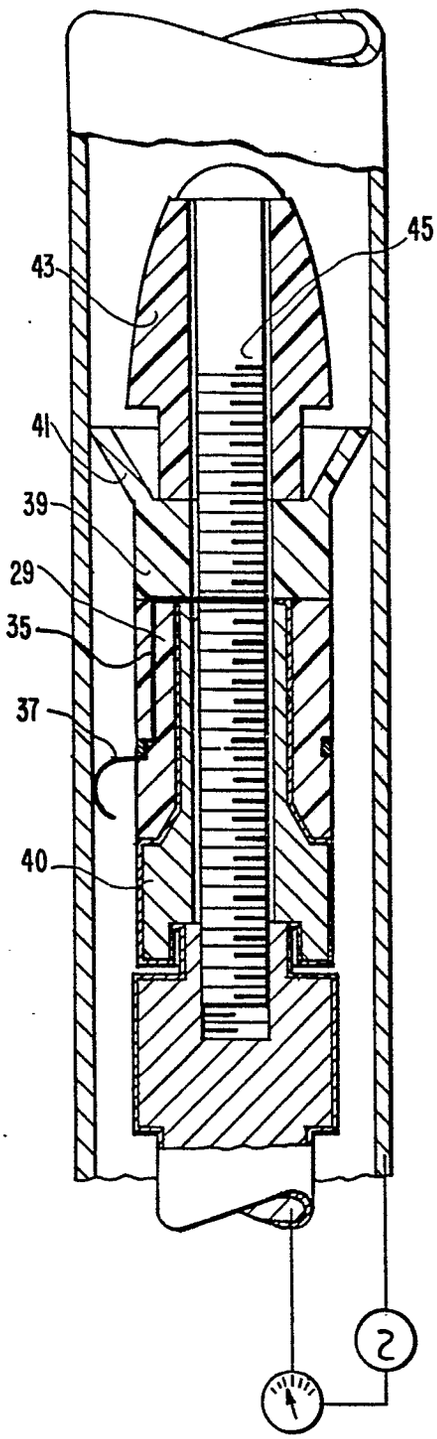

FIG. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application number
EP 79 10 0761

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim
A	GB - A - 853 630 (SOPEMEA)	1
A	FR - A - 1 320 133 (DEHAINE)	1
A	FR - A - 1 330 224 (ROYET)	1
A	FR - A - 1 365 999 (GARNIER)	1
A	FR - A - 1 482 597 (REFIMERIA DE PETROLEOS DE ESCOMBRERAS)	1
A	FR - A - 2 050 309 (ALSTHOM)	1
A	FR - A - 2 292 534 (BALCKE-DURR)	1
A	US - A - 3 831 413 (GLATTHORN)	1
A,P	US - A - 4 125 937 (BROWN)	1

CLASSIFICATION OF THE APPLICATION (Int. Cl.²)

B 21 D 39/20
B 21 D 39/06

TECHNICAL FIELDS SEARCHED (Int.Cl.²)

B 21 D

CATEGORY OF CITED DOCUMENTS

X: particularly relevant
A: technological background
O: non-written disclosure
P: intermediate document
T: theory or principle underlying the invention
E: conflicting application
D: document cited in the application
L: citation for other reasons

&: member of the same patent family, corresponding document

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	18-07-1979	PEETERS L.J.

EPO Form 1503.1 06.78